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RESISTANCE WELDING

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Abstract: *This article describes basic principles of resistance welding and its possible applications. For the design and optimization of welding machines and processes it is necessary to build up the methodology of the modelling of welding process.*

Key words: *Resistance welding*

INTRODUCTION

Resistance welding is a process used to join metallic parts with electric current. There are several forms of resistance welding, including spot welding, seam welding, projection welding, and butt welding.

Due to the fact that many dynamic and interacting parameters are involved in the resistance welding processes, it is a huge task to setup and optimize the production lines applying resistance welding and often difficult to solve welding problems.

1 PHYSICAL PRINCIP OF RESISTANCE WELDING

To create heat, copper electrodes pass an electric current through the work pieces. The heat generated depends on the electrical resistance and thermal conductivity of the metal, and the time that the current is applied. The heat generated is expressed by the equation [1]:

$$E = I^2 . R . t \quad [J] \qquad (1)$$

where is
E heat energy [J];
I current [A];
t time [s].

Copper is used for electrodes because it has a low resistance and high thermal conductivity compared to most metals. This ensures that the heat is generated in the work pieces instead of the electrodes. When the electrodes get too hot, heat marks on the surface of the work pieces can form. The electrodes also become susceptible to "mushrooming". Electrode mushrooming reduces their usable lifetime. To prevent these problems, the electrodes are cooled with water. The water flows inside a cavity in the electrodes, removing excess heat.

The electrodes are held under a controlled force during welding. The amount of force affects the resistance across the interfaces between the work pieces and the electrodes. The force is adjusted to immediately create heat at the interface between the work pieces. The force also refines the grain structure of the weld. If the force is too low expulsion, or weld splash, can occur.

2 RESISTANCE WELDING PROCESSES

Resistance welding is a welding technology widely used in manufacturing industry for joining metal sheets and components. The weld is made by conducting a strong current through the metal combination to heat up and finally melt the metals at localized point(s) predetermined by the design of the electrodes and/or the workpieces to be welded. A force is always applied before, during and after the application of current to confine the contact area at the weld interfaces and, in some applications, to forge the workpieces[2].

2.1 Resistance spot welding

Spot welding is a resistance welding process for joining metal sheets by directly applying opposing forces with electrodes with pointed tips. The current and the heat generation are localized by the form of the electrodes. The weld nugget size is usually defined by the electrode tip contact area.

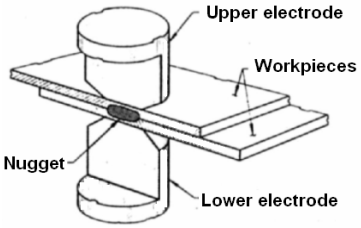

Fig. 1: Resistance spot welding

2.2 Resistance projection welding

Projection welding is a resistance welding process for joining metal components or sheets with embossments by directly applying opposing forces with electrodes specially designed to fit the shapes of the workpieces. The current and the heat generation are localized by the shape of the workpieces either with their natural shape or with specially designed projection. Large deformation or collapse will occur in the projection part of the workpieces implying high process/machine dynamics.

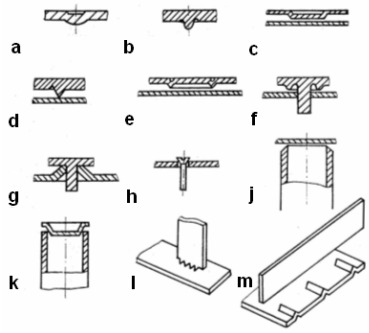

Fig. 2: Resistance projection welding

2.3 Resistance Seam Welding

Seam welding is a resistance welding process for joining metal sheets in continuous, often leak tight, seam joints by directly applying opposing forces with electrodes consisting of rotary wheels. The current and the heat generation are localized by the peripheral shapes of the electrode wheels.

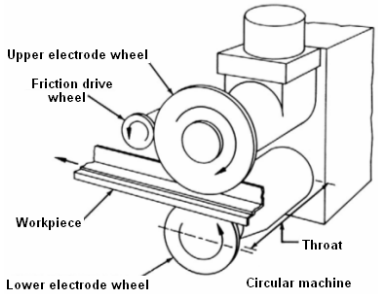

Fig. 3: Resistance seam welding

2.4 Resistance Butt Welding

Butt welding is a resistance welding process for joining thick metal plates or bars at the ends by directly applying opposing forces with electrodes clamping the workpieces. A forging operation is applied after the workpieces are heated up. Often no melt occurs, thus a solid state weld can be obtained.

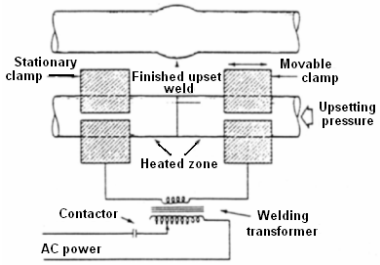

Fig. 4: Resistance spot welding.

3 CONCLUSION

The basic physical principal of the resistance welding was introduced. Typical resistance welding processes were described. For the optimization of welding processes it is necessary to build up numerical models of welding process. Different approaches can be used for the modeling of resistance welding.

4 ACKNOWLEDGEMENT

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5 REFERENCES

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